



PARTICLE POLLUTION

Particle pollution refers to two classes of particles based in part on long-established information on differences in sources, properties, and atmospheric behavior. EPA has set national standards to protect against the health and welfare effects associated with exposures to fine and coarse particles. Fine particles are generally referred to as those particles less than or equal to 2.5 micrometers (μm) in diameter, $\text{PM}_{2.5}$. PM_{10} (particles generally less than or equal to 10 μm in diameter) is the indicator used for the coarse particle standard.

TRENDS IN $\text{PM}_{2.5}$ CONCENTRATIONS

There are two national air quality standards for $\text{PM}_{2.5}$: an annual standard ($15 \mu\text{g}/\text{m}^3$) and a 24-hour standard ($35 \mu\text{g}/\text{m}^3$). Nationally, annual and 24-hour $\text{PM}_{2.5}$ concentrations declined by 9 and 10 percent, respectively, between 2001 and 2007, as shown in Figure 12.

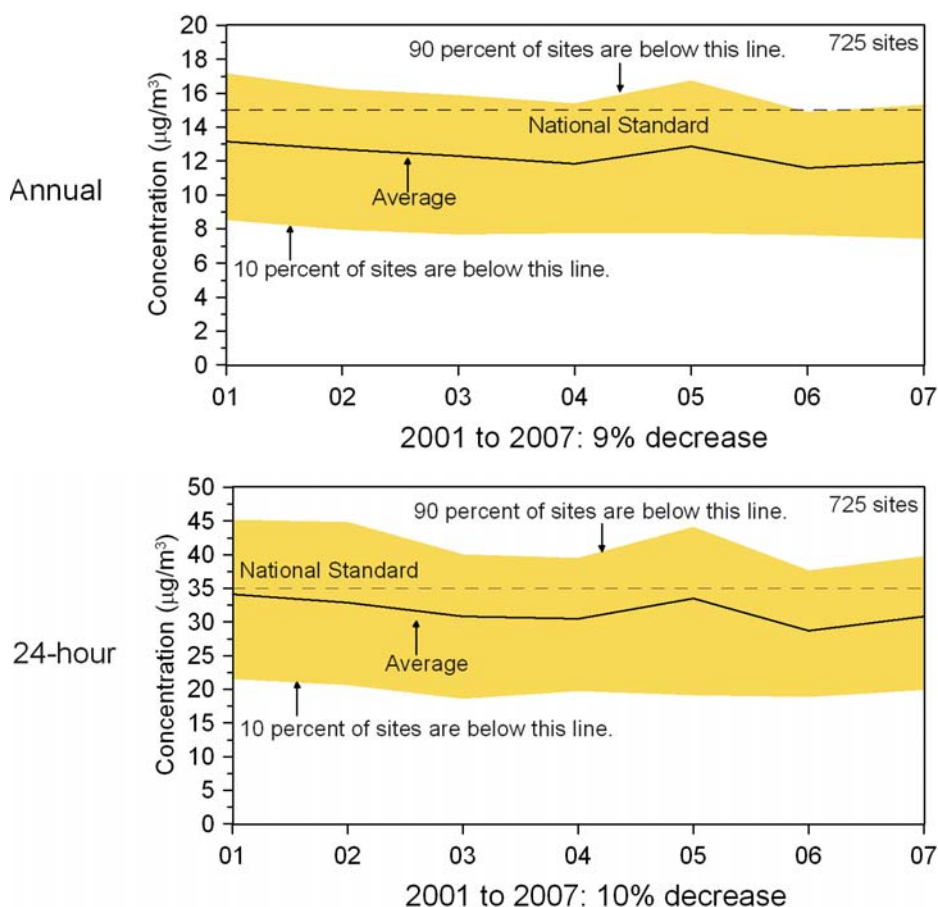


Figure 12. National $\text{PM}_{2.5}$ air quality trends, 2001-2007 (annual and 24-hour average).

Note: In 2006, EPA revised the 24-hour standard from 65 to $35 \mu\text{g}/\text{m}^3$.

The Great American Wood Stove Changeout

Residential wood burning in the U.S. emits 420,000 tons of particle pollution each year. EPA has partnered with the Hearth, Patio, and Barbecue Association, the American Lung Association and state, tribal, and local air quality agencies in the Great American Wood Stove Changeout. This partnership program provides homeowners with information and financial incentives to replace inefficient wood stoves with cleaner-burning gas, wood pellet, and EPA-certified wood stoves. This program can effectively reduce both particle pollution and toxic air pollutants, and help bring areas into attainment with the standards for $\text{PM}_{2.5}$.

As of October 2008, 7600 wood stoves and fireplaces have been replaced nationwide, eliminating close to 200 tons in annual particle pollution emissions, and achieving an estimated \$100 million/year of health benefits.

For more information on wood stoves and the Great American Wood Stove Changeout, visit <http://www.epa.gov/woodstoves/>.



For each monitoring location, the maps in Figure 13 show whether annual and 24-hour $PM_{2.5}$ increased, decreased, or stayed about the same since the beginning of the decade. When comparing two 3-year periods, 2001-2003 and 2005-2007, almost all of the sites show a decline or little change in $PM_{2.5}$ concentrations. Several sites in California showed great improvement for both the 24-hour and annual $PM_{2.5}$ standards. One site in Pennsylvania also showed great improvement in the 24-hour $PM_{2.5}$ concentrations. Eighteen of the 618 sites showed an increase in annual $PM_{2.5}$ concentrations greater than $1 \mu\text{g}/\text{m}^3$. These sites were located in Montana, Arizona, Texas, Arkansas, Louisiana, Alabama, South Carolina, Illinois, and Wisconsin. Of the 18 sites that showed an increase in annual $PM_{2.5}$ concentrations, only two (Birmingham and Houston) were above the

level of the annual $PM_{2.5}$ standard for the most recent year of data (2007). Fifty-eight sites showed an increase in 24-hour $PM_{2.5}$ concentrations greater than $3 \mu\text{g}/\text{m}^3$. Of the 58 sites that showed an increase, 39 were below the level of the 24-hour $PM_{2.5}$ standard for the most recent year of data and 19 were above. The 19 sites above the standard were located in or near the following metropolitan areas: Birmingham, Ala.; Nogales, Ariz.; Chico, Calif.; Paducah, Ky.; Cincinnati, Ohio; Kalamath Falls, Ore.; Pittsburgh, Pa.; Clarksville, Tenn.; Provo, Utah; Green Bay, Wis.; Madison, Wis.; and Milwaukee, Wis. Due to the influence of local sources, it is possible for sites in the same general area to show opposite trends, as in the case of the Pittsburgh area for the 24-hour standard.

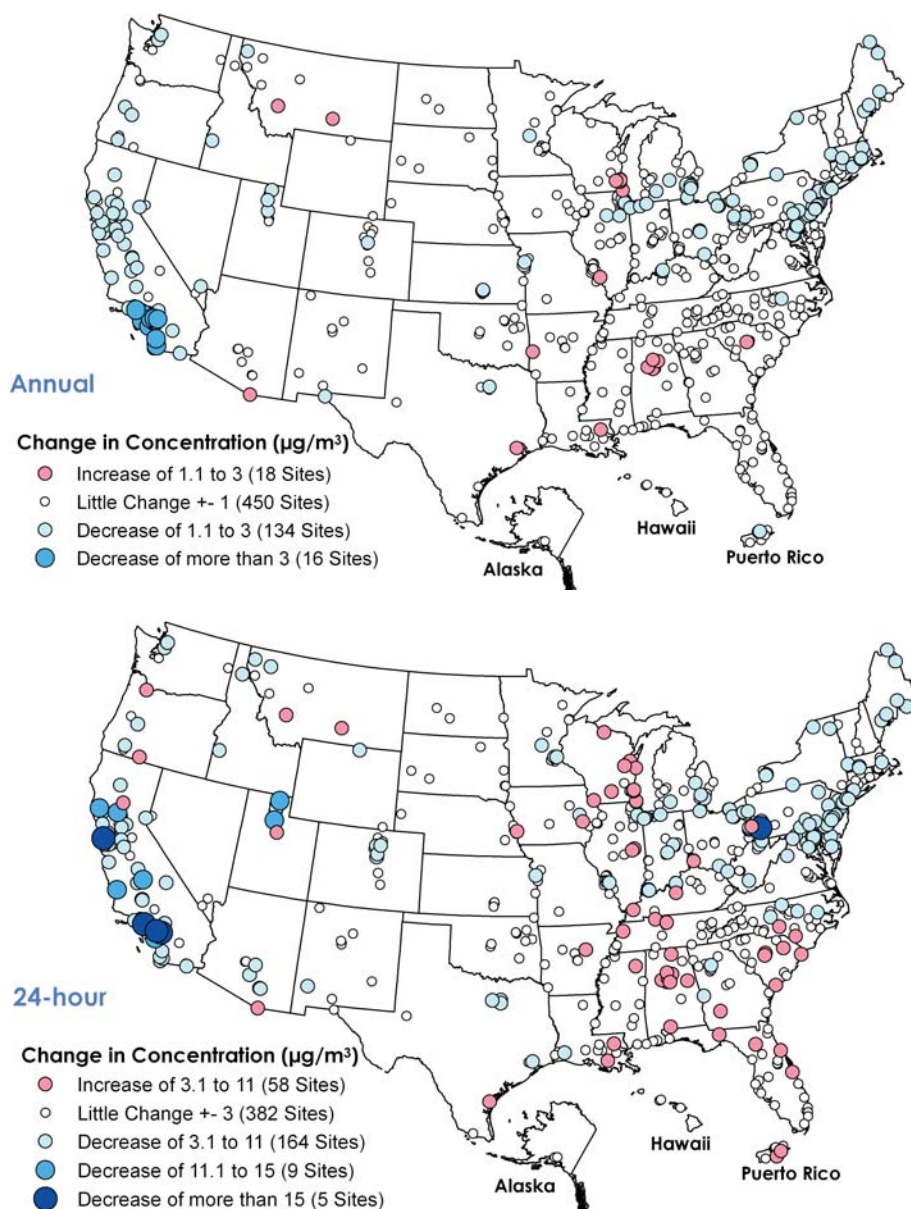


Figure 13. Change in $PM_{2.5}$ concentrations in $\mu\text{g}/\text{m}^3$, 2001-2003 vs. 2005-2007 (3-year average of annual and 24-hour average concentrations).

In 2007, the highest annual average $PM_{2.5}$ concentrations were in California, Arizona, Alabama, and Pennsylvania, as shown in Figure 14. The highest 24-hour $PM_{2.5}$ concentrations were in California, Idaho, and Utah. Even though California and Pennsylvania showed the greatest improvement since the start of the decade, they had some of the highest concentrations in 2007.

Some sites had high 24-hour $PM_{2.5}$ concentrations but low annual $PM_{2.5}$ concentrations, and vice versa. Sites that have high 24-hour concentrations but low or moderate annual concentrations exhibit substantial

variability from season to season. For example, sites in the Northwest generally have low concentrations in warm months but are prone to much higher concentrations in the winter. Factors that contribute to the higher levels in the winter are extensive wood stove use coupled with prevalent cold temperature inversions that trap pollution near the ground. Nationally, more sites exceeded the level of the 24-hour $PM_{2.5}$ standard than exceeded the level of the annual $PM_{2.5}$ standard, as indicated by yellow and red dots on the maps below. About one-third of the sites that exceeded either standard exceeded both standards.

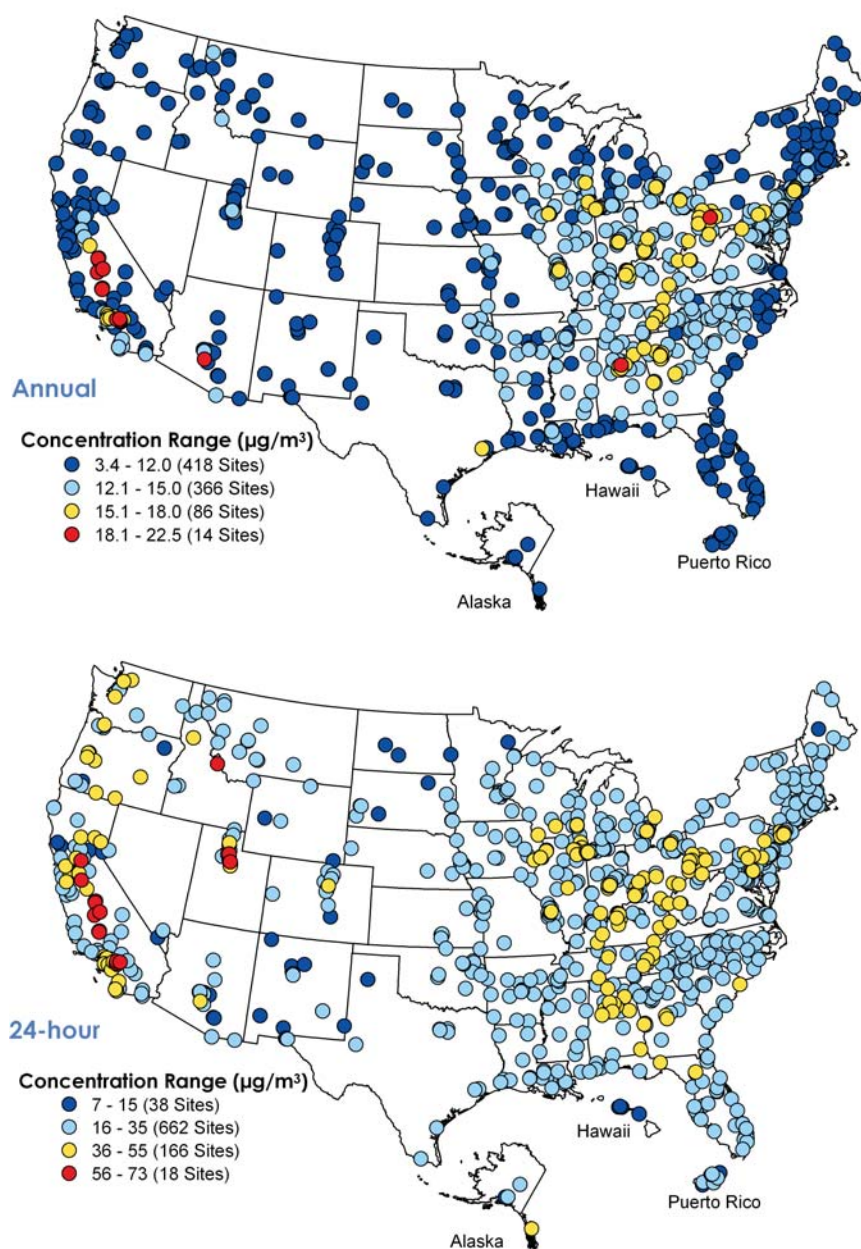


Figure 14. Annual average and 24-hour (98th percentile 24-hour concentrations) $PM_{2.5}$ concentrations in $\mu g/m^3$, 2007.

WEATHER CONDITIONS INFLUENCE PM_{2.5}

As for ozone, in addition to emissions, weather plays an important role in the formation of PM_{2.5}. Figure 15 shows trends in PM_{2.5} from 2001 through 2007, before and after adjusting for weather. PM_{2.5} levels are monitored throughout the year, separate graphs are shown for the warm and cool months. After adjusting

for weather, PM_{2.5} concentrations have decreased by approximately 11 percent in both the warm and the cool season between 2001 and 2007. Weather influences during the warm season are generally larger than for the cool season, which is consistent with seasonal changes in emissions and temperature effects on the formation of secondary particle pollutants.

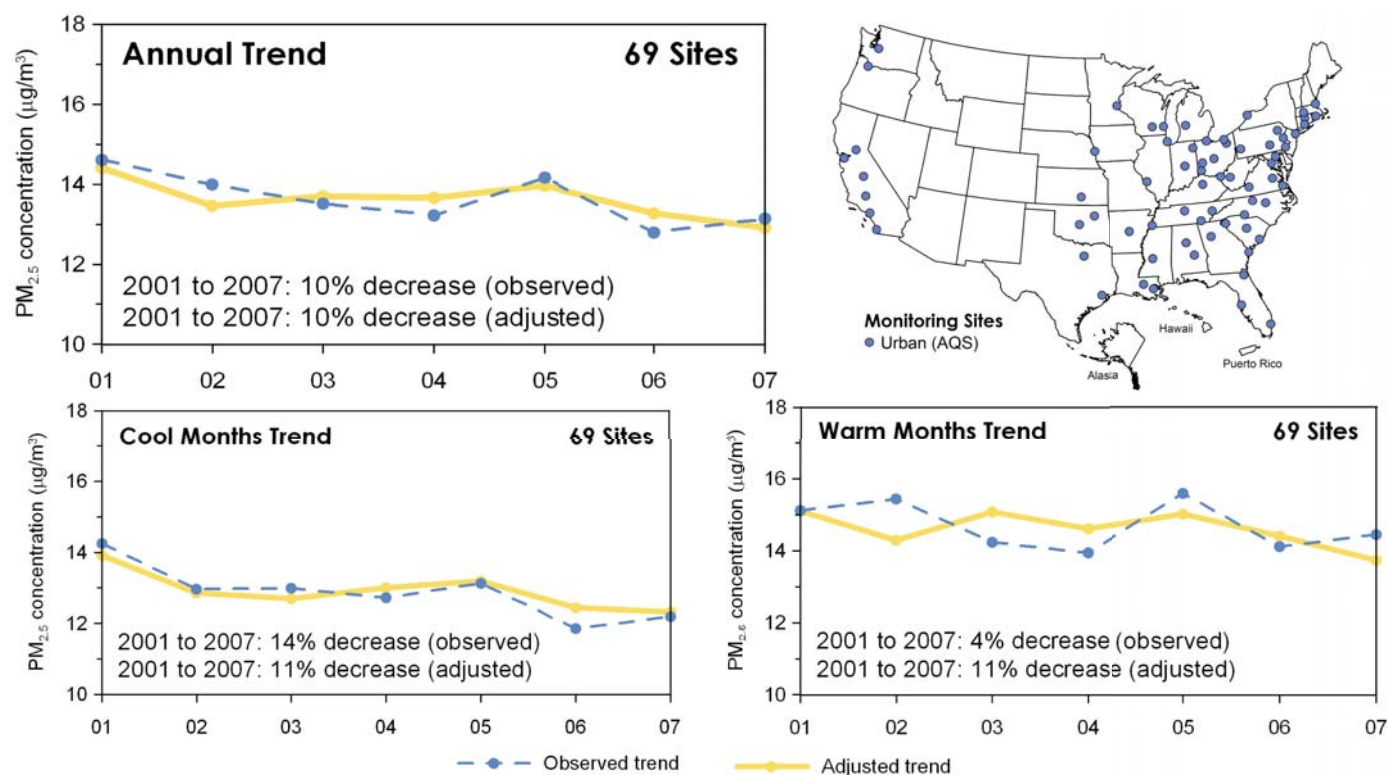


Figure 15. Trends in annual, cool months (October–April), and warm months (May–September) average PM_{2.5} concentrations, before and after adjusting for weather, and the location of urban monitoring sites used in the average.

TRENDS IN PM_{2.5} COMPOSITION 2002-2007

The mixture of different chemical components which make up PM_{2.5} varies by season and location. This is true because of the differences in emissions and weather conditions that contribute to the formation and transport of PM_{2.5}. In general, PM_{2.5} is primarily composed of sulfate, nitrate, organic carbon, and, to a lesser degree, elemental carbon and crustal material. Figure 16 shows regional trends in the composition of PM_{2.5} from 2002 to 2007 for warm and cool months.

Sulfate levels are generally higher in the warm months and can account for the largest chemical component of PM_{2.5} mass. Sulfate concentrations are their lowest in the Northwest. Also, the sulfate portion of PM_{2.5} mass is lower in the Northwest than in any other region. Slight

declines in sulfate levels are shown in the Northeast and Southeast during the cooler months. The highest sulfate concentrations appeared in the Southeast, Northeast, and Midwest during warm months of 2005, partly due to atypical weather conditions. The largest sources of sulfate in the eastern U.S. are SO₂ emissions from electric utilities and industrial boilers. In southern California and port cities in the Northwest, sulfates likely come from marine vessels.

Organic carbon is also a major component of PM_{2.5} throughout the year in all regions. Organic carbon concentrations are highest in southern California and the Southeast. Organic carbon levels are the largest component of PM_{2.5} in southern California and the Northwest during the cool months. Declines are shown

year-round for southern California and during the warm months in the Northeast. The largest sources of organic carbon are VOCs and direct carbon emissions from highway vehicles, non-road mobile, waste burning, wildfires, and vegetation. In the western U.S., fireplaces and wood stoves are important contributors to organic carbon.

Nitrate concentrations are higher in the cool months than in the warm months. The lowest nitrate levels are in the Northeast and the Southeast. Nitrate levels have declined substantially in southern California and

slightly in all the other regions, except the Northwest, which shows no discernible trend. The largest sources of nitrates are NO_x emissions from highway vehicles, non-road mobile, electric utilities, and industrial boilers. Ammonia from sources such as fertilizer and animal feed operations contributes to the formation of sulfates and nitrates that exist in the air as ammonium sulfate and ammonium nitrate.

The remaining two components, elemental carbon and crustal material, are comparatively small but also exhibit some seasonal variability.

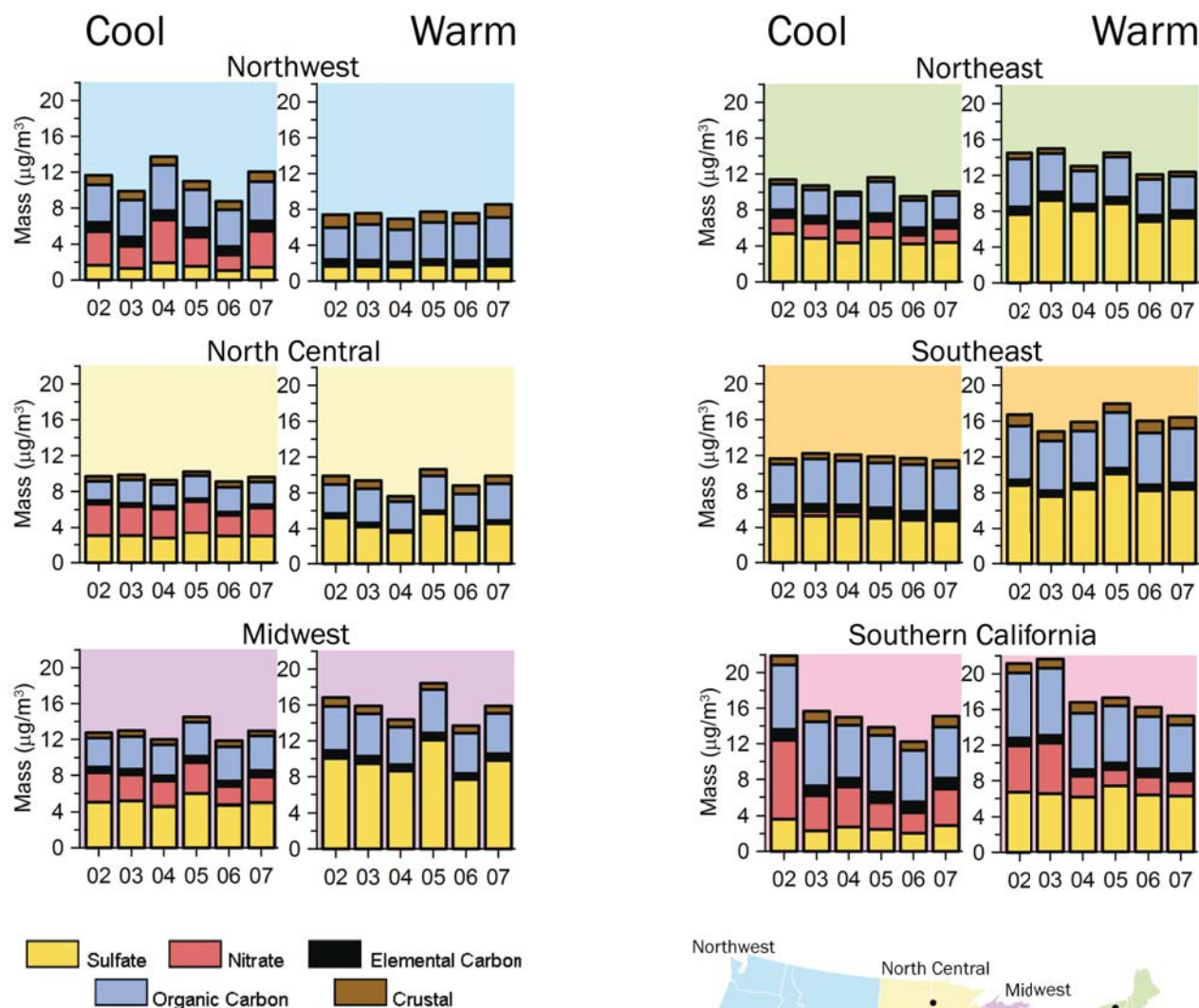


Figure 16. Regional and seasonal trends in annual $\text{PM}_{2.5}$ composition in $\mu\text{g}/\text{m}^3$, 2002-2007.

Note: This figure is based on 42 monitoring locations with the most complete data from the national chemical speciation network for 2002-2007. There were no sites with complete data in the Southwest. For related information, read "Retained nitrate, hydrated sulfates, and carbonaceous mass in federal reference method fine particulate matter for six eastern U.S. cities," by N. H. Frank, *J. Air & Waste Manage. Assoc.* **56**, Pages 500-511, 2006.

TRENDS IN PM₁₀ CONCENTRATIONS

Nationally, 24-hour PM₁₀ concentrations declined by 21 percent between 2001 and 2007 as shown in Figure 17.

When comparing two 3-year periods, 2001-2003 and 2005-2007, most of the sites (nearly 90 percent) showed a decline or little change in PM₁₀ as shown in Figure 18. Twenty sites located in the Southwest, South Carolina, Missouri, and Wyoming showed a greater than 50 $\mu\text{g}/\text{m}^3$ decline. Seventy-four sites showed an increase of greater than 10 $\mu\text{g}/\text{m}^3$ over the trend period. Four of these sites (Houston, Texas; Rock Springs, Wyo.; Albany, Ga.; and Las Cruces, N.M.) showed large increases of 50 $\mu\text{g}/\text{m}^3$ or more.

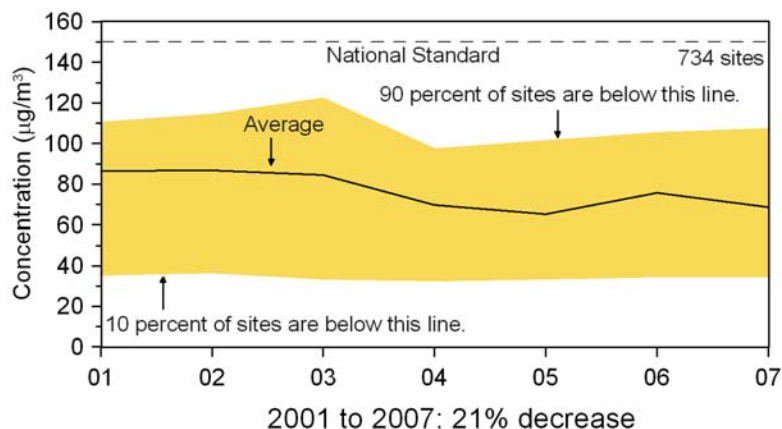


Figure 17. National PM₁₀ air quality trend, 2001-2007 (second maximum 24-hour concentration).

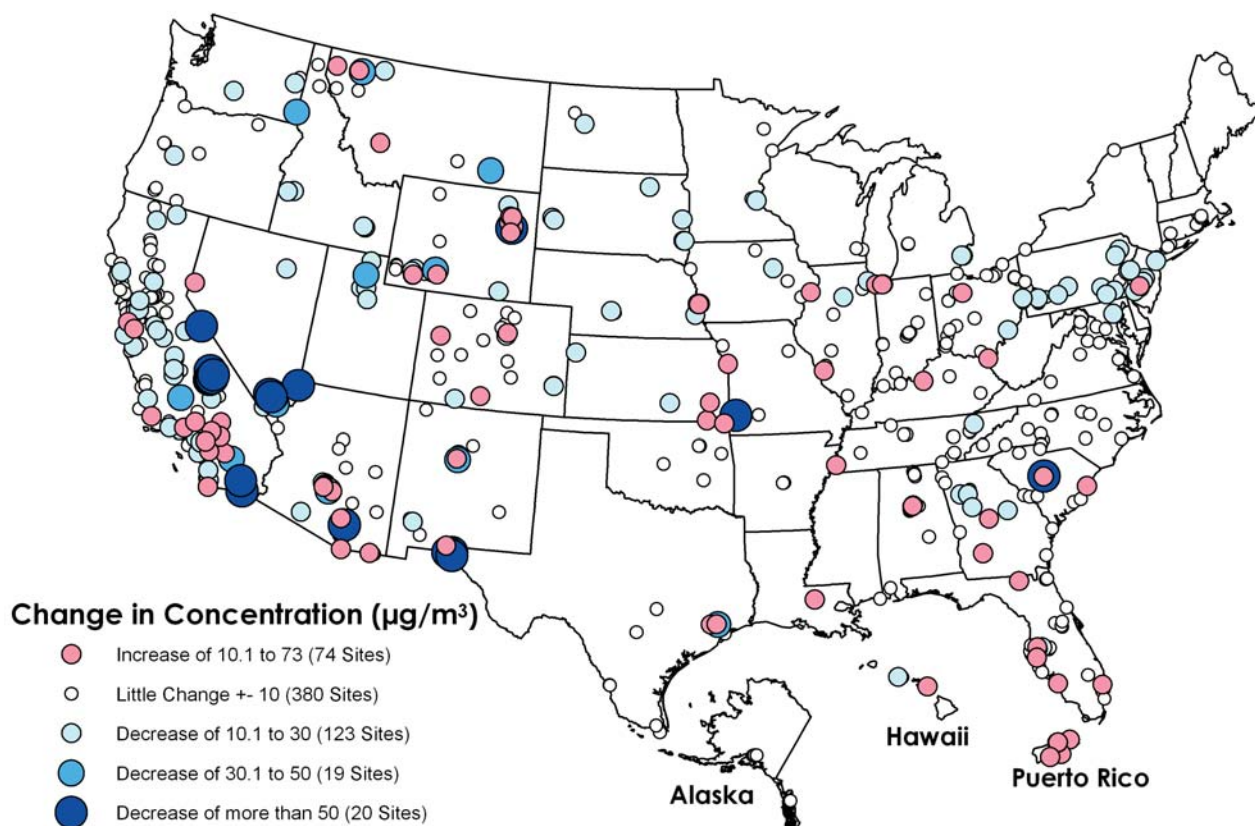


Figure 18. Change in PM₁₀ concentrations in $\mu\text{g}/\text{m}^3$, 2001-2003 vs. 2005-2007 (3-year average of annual average concentrations).

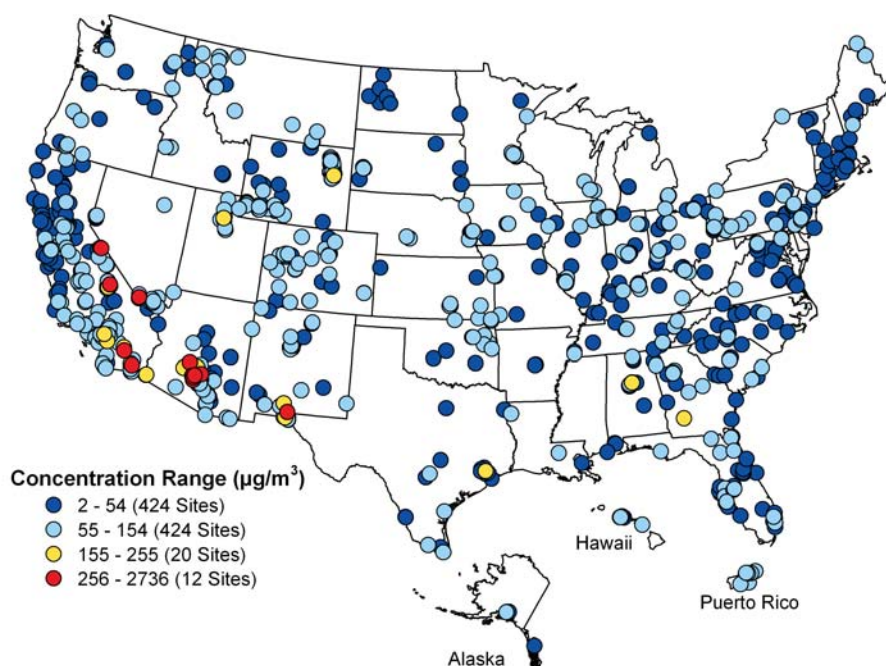


Figure 19 shows that in 2007, the highest PM_{10} concentrations were located in California, Nevada, Arizona, and New Mexico. This is also where some of the sites showed a greater than $50 \mu\text{g}/\text{m}^3$ decline. Highest concentrations are largely located in dry and/or industrial areas with high coarse particle sources.

Figure 19. PM_{10} concentrations in $\mu\text{g}/\text{m}^3$, 2007 (second maximum 24-hour concentration).



Sustainable Skylines Initiative

EPA's Sustainable Skylines Initiative (SSI) is an innovative approach to achieve sustainable air quality and other environmental improvements including reducing the six common air pollutants, toxic air pollutants, and greenhouse gases. Participating cities may integrate transportation, energy, land use, and air quality planning efforts to achieve measurable emissions reductions within three years.

Each program is locally-driven, provides for collaboration among multiple stakeholders, identifies and leverages resources among public and private partners, and utilizes a consensus-based approach. Initiatives to encourage use of sustainable practices to help the air quality are already underway in Dallas, Texas; Kansas City, Kan.; and Missouri. EPA plans to have 10 cities in the program by the end of 2010.

Sustainable skyline projects include:

- Linking green building techniques with affordable housing initiatives.
- Decreasing the amount of heated surfaces within the central city.
- Increasing permeability of surfaces within the central city.
- Conducting pollution prevention audits for small businesses to reduce energy consumption and environmental impacts.
- Reducing landscape equipment emissions through sustainable lawn irrigation and turf management.
- Lowering vehicle emissions by increasing public transportation and reducing vehicle miles traveled.
- Converting parking lots to parks.
- Reducing engine idling and applying retrofits to diesel engines.
- Retrofitting or replacing small off-road equipment to reduce emissions.



For more information about Dallas, visit <http://www.sustainableskylines.org/Dallas/>.



For more information about Kansas City, visit <http://www.epa.gov/region7/citizens/ssl.htm>.